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(56) Documents Cited
EP 0615395 A1 EP 0505341 A2 EP 0466543 A1
WO 93/12587 A1 WO 92/12601 A1 US 5504938 A
US 4435840 A

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(54) Improved Flow Control in Cellular Radio Networks

(57) A method of controlling the traffic flow in a cellular radio system, in which the traffic load on each base station of the system is continuously monitored and a parameter adapted to control the access of new mobile stations to a given base station is varied continuously with the load in that base station.

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

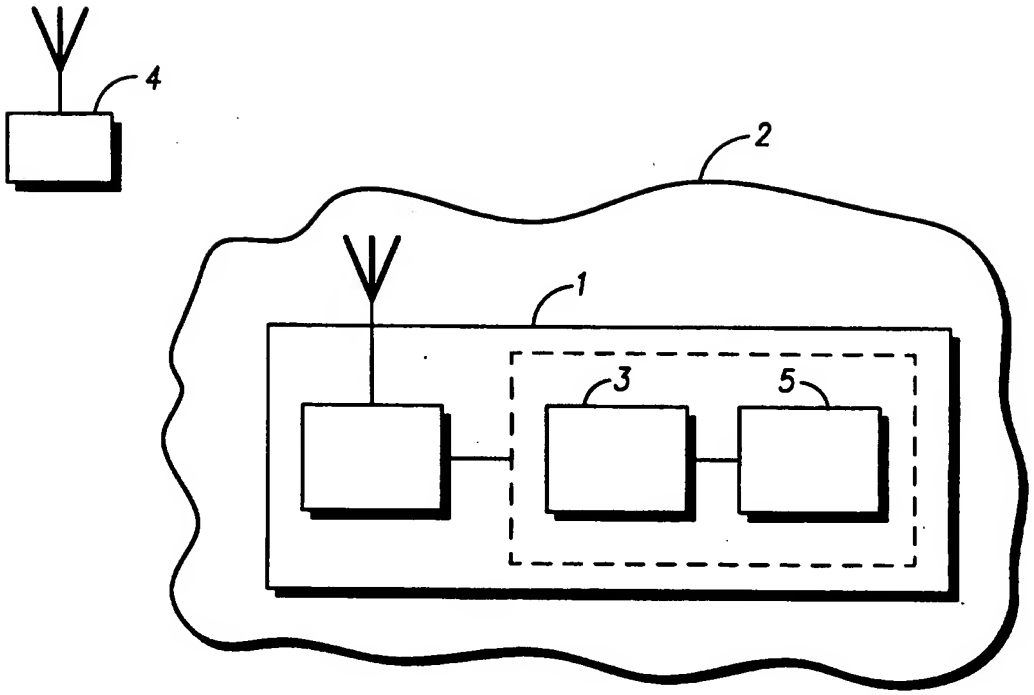
4
2
1
3
5

FIG.1

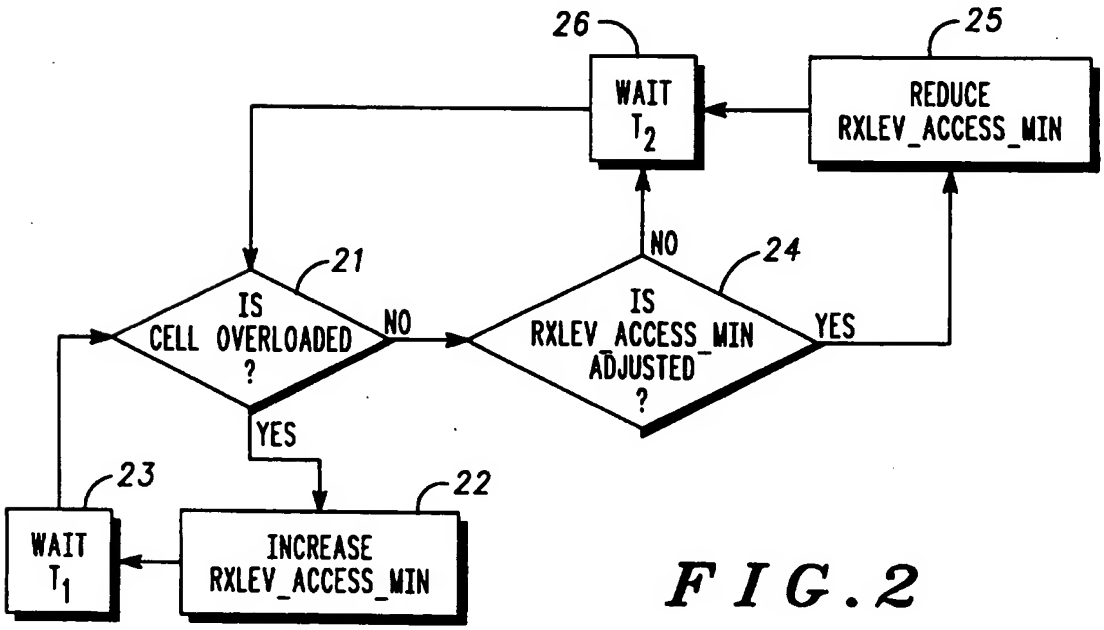
26
25
WAIT
T_2
REDUCE
RXLEV_ACCESS_MIN
NO
21
24
IS
CELL OVERLOADED
?
NO
IS
RXLEV_ACCESS_MIN
ADJUSTED
?
YES
YES
23
22
WAIT
T_1
INCREASE
RXLEV_ACCESS_MIN

FIG.2

Improved Flow Control in Cellular Radio Networks

Field of the Invention

The present invention relates to methods for reducing traffic congestion in cells of cellular radio communication systems.

Background of the Invention

In principle, cellular radio communication systems consist of a number of base stations in an area delineated by the ranges of transceivers forming part of the base stations. The area covered by each base station of the system constitutes a cell of the system. Mobile stations are dispersed throughout each cell of the system and they have to be linked to one or other of the base stations as they move from one cell to another. The base stations radiate beacon signals of a standard strength and mobile stations monitor the relative strengths of beacon signals received from a number of base stations in their vicinity. This data is relayed to the base station to which they are linked at any given moment or a control centre which then determines which base station beacon signal exceeds the others by a pre-determined amount, known as the handover margin and initiates the transfer of the mobile station to that base station. Alternatively, the mobile station may carry out the base station selection process.

Ideally, to make the most efficient use of the system, each cell of the system should carry the same amount of traffic. Of course, in practice this does not occur because mobile stations enter or leave given cells and the number of calls made to and from each mobile station varies continuously. As a result, the traffic channels of one base station may be saturated while neighbouring base stations have traffic capacity unused. Various ways to overcome this problem have been proposed. For example, in a

paper entitled "Traffic Sharing Scheme for Distributed Dynamic Channel Allocation" by Matsuma Serizawa et al, published in Mobile and Personal Communications 13-15 pp 131-135 Dec. 93 there is disclosed a method of diverting overload traffic in a cellular radio communication system by reducing the power of the beacon signals generated by busy base stations in the system. As mobile stations select base stations on the basis of the received strength of beacon signals, fewer mobile stations select busy base stations, so relieving the load upon them. In effect, the size of a cell varies according to the traffic within it. However, the traffic level is maintained near the saturation level and also, because a given busy base station covers a smaller area, the problem of traffic overload could well be exacerbated rather than relieved.

Summary of the Invention

According to the present invention there is provided a method of controlling the traffic flow in a cell forming part of a cellular radio communication system, comprising the operations of continuously monitoring the traffic load upon a base station associated with the cell and varying continuously in response thereto a parameter adapted to control the access of new mobile stations to the said base station, thereby to reduce variations in the traffic load on the said base station.

In the digital cellular radio system set up under the auspices of a body known as Global System for Mobile Communications (GSM), a mobile station determines which cell with which it should be linked by means of a criterion known as the path loss criterion, which is defined in GSM Recommendation 05.08.01 as:

$$CI = (A - \mathrm{Max}(B, 0))$$

where A is the mean signal strength received by the mobile station from a base station minus a parameter known as RXLEV_ACCESS_MIN which defines a power criterion for a connection to be made between a mobile station and a base station, and Max(B,0) is a parameter related to the power classes of the base station and mobile station which defines whether the base station is eligible for access to the base station at all. Both RXLEV_ACCESS_MIN and Max(B,0) are defined in GSM Recommendation 05.08.

A mobile station will seek to make contact with a cell for which the parameter CI is a maximum, hence by varying this parameter, one can control the likelihood that a mobile station at the periphery of a cell and seeking a traffic channel, will look elsewhere if that cell is congested, and, if all the cells in the system operate in the same way, then the new mobile station will be directed to that cell which offers the best combination of effective communication and lack of congestion. The great advantage, compared with existing GSM systems, particularly, is that a new call is not rejected merely because there is no traffic channel available in the cell which encompasses the area in mobile station seeking to make the new call.

The most appropriate component of the criterion C1 to vary is the parameter RXLEV_ACCESS_MIN, and in a preferred form of the present invention the level of congestion, oR the traffic overload, at the base station of any given cell is monitored continuously and the value of the term RXLEV_ACCESS_MIN is varied inversely with the level of congestion at the said base station and preferably is directly proportional to the reciprocal of the level of congestion at the base station. Suitably, during periods of congestion the value of the parameter RXLEV_ACCESS_MIN is increased in the range 0-31dB, usually 5dB and at other

times it is decreased by an amount also in the range 0-31dB, usually 5dB.

A suitable criterion for judging the level of congestion at the base station is the number of requests for traffic channels which are queued at the base station.

Other criteria which can be used for judging the level of congestion, or traffic overload, at the base station are the number of traffic channels which are available at the base station, a specified period of time for which a request for a traffic channel is held in a queue at the base station, or the load upon the central processing unit of the base station.

Brief Description of the Drawings

The invention will now be described, by way of example with reference to the accompanying drawings, in which,

FIG. 1 is a schematic representation of an embodiment of the present invention, and

FIG. 2 is a flow chart of an access control process which is included in the embodiment of FIG. 1.

Description of a Preferred Embodiment

Referring to FIG. 1 of the drawings, a base station 1 of a cell 2 which forms part of a cellular communication system includes an overload detector circuit 3 which logs the number of requests for traffic channels from mobile stations (only one of which is shown) if this exceeds a pre-determined value chosen by the operator of the system, then an overload condition is deemed to exist and an access control circuit 5 is activated to increase the previously described parameter RXLEV_ACCESS_MIN to bar access to the base station 1, and cause the mobile station 4 to seek

traffic channels in neighbouring cells. If no overload condition exists at the base station 1, then the call is accepted in the usual way.

The monitoring to determine whether an overload conditions exists at the base station 1 is continuous and the action of the process and its associated access control circuit 5 is shown in the form of the control loop shown in FIG. 2.

Referring to FIG. 2, the overload detector 3 is interrogated to determine if an overload condition exists (stage 21); if so then the access control circuit 5 is activated to increase the value of the parameter RXLEV_ACCESS_MIN by a selected value in the range 0-31 dB over its normal value, a usual figure being 5 dB (stage 22). This condition is maintained for a period T_1 of between 0 and 60 secs, as chosen by the operator of the system (stage 23). At the end of this period the overload detector circuit is interrogated again (stage 21). If the overload condition continues then the increased level of the parameter RXLEV_ACCESS_MIN is maintained for another period T_1, and so on. On the other hand, if the overload condition has cleared, or if it did not exist in the first place, a check is made to see if the parameter RXLEV_ACCESS_MIN is at its increased value (stage 24). If this is so, then a circuit is activated to reduce the value of the parameter RXLEV_ACCESS_MIN to a value at least equal to the normal value, and possibly below it by an amount in the range 0-31 dB, but again a value of about 5dB is usual (stage 25). This encourages new mobile stations 4 to seek to make contact with the base station 1. If the value of the parameter RXLEV_ACCESS_MIN has been decreased, or if its value had not been increased when the check of stage 24 was made, the lower value of the parameter RXLEV_ACCESS_MIN is maintained for a selected period of time in the range 0-

60 seconds (stage 26) and the overload detector 3 is interrogated to determine if an overload condition exists. If it does not, or has cleared, then the second loop is repeated again.

All the cells in the cellular radio communication system operate in the same way so that traffic is shared among them, and unlike conventional GSM systems, new calls are not rejected entirely because an initially called base station is overloaded.

In the example described above, the criterion for deciding whether or not congestion or traffic overload exists at the bast station is the number of requests for a traffic channel from the mobile stations 4 which are held in a queue by the central processing unit of the base station 1.

Other criteria which can be used are:

a) The period of time for which a given request for a traffic channel is held in a queue by the central processing unit of the base station,

b) The number of free traffic channels available at the base station - as this decreases towards zero, so the value of the parameter RXLEV_ACCESS_MIN is raised, or

c) The load upon the central processing unit of the base station.

Claims

1. A method of controlling the traffic flow in a cell forming part of a cellular radio communication system, comprising the operations of continuously monitoring the traffic load upon a base station associated with the cell and varying continuously in response thereto a parameter adapted to control the access of new mobile stations to the said base station, thereby to reduce variations in the traffic load on the said base station.

2. A method according to Claim 1 wherein the said parameter is varied inversely with the level of congestion at the base station.

3. A method according to Claim 2 wherein the said parameter is varied in direct proportion to the reciprocal of the level of congestion at the base station.

4. A method according to Claim 2 or Claim 3 wherein the level of congestion at the base station is a function of the number of requests for a traffic channel from mobile stations which are held in a queue by a central processing unit forming part of the base station.

5. A method according to Claim 2 or Claim 3 wherein the level of congestion at the base station is a function of the time for which a request from a mobile station is held in a queue by a central processing unit forming part of the base station.

6. A method according to Claim 2 or Claim 3 wherein the level of congestion at the base station is a function of the number of free traffic channels at the base station.

7. A method according to Claim 2 or Claim 3 wherein the degree of congestion at the base station is a function of the load upon a central processing unit forming part of the base station.

8. A method according to any preceding claim wherein the said parameter is that known under GSM recommendation 05.08 as RXLEV_ACCESS_MIN.

9. A method according to Claim 8 wherein the value of the parameter RXLEV_ACCESS_MIN is varied between the limits of ±31 dB of a specified base value.

10. A method according to Claim 9 wherein the value of the parameter RXLEV_ACCESS_MIN is varied between the limits ±5 dB of the specified base value.

11. A method of controlling the traffic flow in a cell of a cellular radio communication system substantially as hereinbefore described and with reference to the accompanying drawings.

The Patent Office

Application No:	GB 9614783.0	**Examiner:**	Nigel Hall
Claims searched:	all	**Date of search:**	22 October 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H4L (LDSG, LDSX)

Int Cl (Ed.6): H04Q 7/22, 7/36

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	EP 0615395 A1	(HITACHI) See whole document	1-3 at least
X	EP 0505341 A2	(ERICSSON) See whole document	1-3,6 at least
X	EP 0466543 A1	(FRANCE TELECOM) See whole document	1,4,6 at least
X	WO 93/12587 A1	(NOKIA) See whole document	1 at least
X	WO 92/12601 A1	(MOTOROLA) See whole document	1-3 at least
X	US 5504938	(REDDEN) See whole document	1-3,6 at least
X	US 4435840	(KOJIMA) See whole document	1-3,6 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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